



DEPARTMENT OF THE NAVY

PROGRAM EXECUTIVE OFFICE SHIPS
1333 ISAAC HULL AVENUE SE
WASHINGTON NAVY YARD, DC 20376-2101

IN REPLY REFER TO
3530
Ser PMS501/512
3 May 11

From: Program Manager, Littoral Combat Ship (PMS 501)
To: Commanding Officers, USS FREEDOM (LCS 1) (BLUE) and (GOLD)

Subj: SAFE OPERATING ENVELOPE (SOE) NEAR TERM GUIDANCE BASED ON
HULL CRACK INVESTIGATION FINDINGS

Ref: (a) SEA 05 LCS 1 Near-Term Operational Guidance based on
Hull Crack Investigation

1. This letter provides guidance to ship's force for near term operation of USS FREEDOM (LCS 1). During the ongoing investigation of the hull crack, there have been several areas identified that require additional inspection while the ship is in dry-dock during the upcoming PSA. Additionally, there are several design corrections/improvements to mitigate hull stresses throughout the full Safe Operating Envelope (SOE) that will also be executed during the docking period.

2. Within the ship's previous operational history and planned underway schedule, LCS 1 is expected to be fully capable of operating within the guideline noted in the existing Safe Operating Envelope (SOE). However, given the concerns for weld quality, chock design/implementation, and the underwater location of the weld seam, there is risk associated with operating LCS 1 at the extreme edges of its SOE while transiting or deployed at significant distances from/to port (open ocean transit). It is therefore, prudent to plan ahead for possible mitigating situations where LCS 1 might be required to deviate from planned underway mission. Attached is the NAVSEA 05D recommendation for specialized, near-term operational guidance.

3. PMS 501 Point of Contact is Mr. Joe DePietro at
(202) 781-3466 or joseph.depietro@navy.mil.


J. S. RIEDEL

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DEPARTMENT OF THE NAVY

NAVAL SEA SYSTEMS COMMAND
1333 ISAAC HULL AVENUE
WASHINGTON NAVY YARD DC 20376-0001

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9000
Ser 05D/116
6 April 11

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MEMORANDUM

From: LCS In-Service Ship Design Manager (SEA 05D5)
To: LCS Program Manager (PMS 501)
Subj: LCS 1 NEAR-TERM OPERATIONAL GUIDANCE BASED ON HULL CRACK
INVESTIGATION - ADDENDUM
Encl: (1) Weld Inspection Results for Lack of Penetration
(2) Chock Inspection Results
(3) Safe Operating Envelope (SOE) For LCS 1 (Rev 1) 12
Feb 2010

1. NAVSEA 05 is conducting an investigation into the root cause of a crack found in the hull of the Lockheed Martin (LM) LCS 1, USS FREEDOM. Initial Ultrasonic Test (UT) findings indicate several additional areas possessing lack of fusion and partial penetration, enclosure (1). The investigation, to-date, has also uncovered many missing, under-sized and misaligned chocks throughout the ship, enclosure (2).

2. Within the ship's previous operational history and planned underway schedule, LCS 1 is expected to be fully capable of operating within the guideline noted in the existing Safe Operating Envelope (SOE), enclosure (3). However, given the concern for weld quality, missing and under-sized chocks, and the underwater location of the weld seam, there is risk associated with operating LCS 1 at the extreme edges of its SOE while transiting or deployed at significant distances from/to port (open ocean transit). It is therefore, prudent to plan ahead for possible mitigating situations where LCS 1 might be required to deviate from planned underway mission. NAVSEA 05D is recommending specialized, near-term operational guidance. The following operational guidance is a culmination of these factors and considerations:

a. During periods when LCS 1 is operating less than 12 hours from port, the spray chine detail from frame 11 to 27 and from frame 40 to 55, on both the port and starboard side, are to

Subj: LCS 1 NEAR-TERM OPERATIONAL GUIDANCE BASED ON HULL CRACK INVESTIGATION

be visually inspected weekly where access is practical. If a crack should occur, the crack's maximum permitted size will be limited to either 12 inches or a condition based on the crew's ability to de-water the affected compartment(s). If either of these conditions occur, the ship will return to port. Inspection periodicity will change to daily if any cracks are discovered. Within the operational area, the ship may operate to the existing SOE.

b. During periods when LCS 1 is operating greater than 12 hours but less than 36 hours from port, the spray chine detail from bow to frame 27 and from frame 40 to 55, on both the port and starboard side, are to be visually inspected daily where access is practical. If a crack should occur, the crack's maximum permitted size will be limited to either 6 inches or a condition based on the crew's ability to dewater the affected compartment(s). If either of these conditions occur, the ship will return to port. Within this operational area, the ship may operate to the existing SOE, but is not to exceed Sea State (SS) 6.

c. During periods when LCS 1 is operating greater than 36 hours from port (including open-ocean transit), the spray chine detail from bow to frame 27 and from frame 40 to 55, on both the port and starboard side, are to be visually inspected daily where access is practical. If a crack should occur, the crack's maximum permitted size will be limited to either 3 inches or a condition based on the crew's ability to dewater the affected compartment(s). If either of these conditions occur, the ship will return to port. Within this operational area, the ship may operate to the existing SOE, but is not to exceed SS 5.

d. In addition to all above visual inspections periodicities, event-driven inspections of the same areas shall be performed immediately following significant slamming events or following encounters in SS 5 and above.

e. This guidance will be re-evaluated after Post Shakedown Availability (PSA) 1.

Subj: LCS 1 NEAR-TERM OPERATIONAL GUIDANCE BASED ON HULL CRACK
INVESTIGATION

3. John Fulton, the LCS In-Service SDM, shall be notified
immediately upon the discovery of any hull cracks at Office:
(202) 781-3351 Mobil: (202) 239-9892.


John P. Fulton

Copy to:
PMS 501
SEA 05D
SEA 05P

ENCLOSURE (1)

LCS-1 USS FREEDOM

Ultrasonic Inspection of High Stress Frames

Frame	See it?	Notes	Space #	substitute Fr	Chock OK	Chock SM	No Chock	Pen	SW
18 Port									
Top Fwd	Yes		3-11-2-L		X			SAT	SAT
Bottom Fwd	No	inaccessible	3-11-2-L		N/A				
Top Aft	Yes		3-18-4-L		X			SAT	SAT
Bottom Aft	Yes	inaccessible	3-18-4-L		N/A				
18 STBD									
Top Fwd	Yes		3-15-1-L		X			SAT	SAT
Bottom Fwd	No	inaccessible Due to config.	3-15-1-L		N/A				
Top Aft	Yes		3-18-1-L		X			SAT	SAT
Bottom Aft	No	inaccessible Due to config.	3-18-1-L		N/A				
23 Port (See note 1/)									
Top Fwd	No	inaccessible Due to false deck	3-18-4-L	22 fwd top			X	SAT	SAT
Bottom Fwd	No	inaccessible Due to false deck	3-18-4-L						
Top Aft	No	inaccessible Due to false deck	3-18-4-L	21 aft top			X	SAT	1/2"
Bottom Aft	No	inaccessible Due to false deck	3-18-4-L						
23 STBD (see notes 2/ and 3/)									
Top Fwd	No	inaccessible Due to false deck	3-18-1-L	22 fwd top			X	LOP	PARTIAL
Bottom Fwd	No	inaccessible Due to false deck	3-18-1-L						
Top Aft	No	inaccessible Due to false deck	3-18-1-L	21 aft top			X	SAT	1/4"
Bottom Aft	No	inaccessible Due to false deck	3-18-1-L						
26 Port									
Top Fwd	No	inaccessible Due to cableway	5-18-01-E AMR1						
Bottom Fwd	No	inaccessible Due to cableway	5-18-01-E AMR1						
Top Aft	No	inaccessible Due to cableway	5-26-01-E GTMR						
Bottom Aft	No	inaccessible Due to cableway	5-26-01-E GTMR						
26 STBD									
Top Fwd	No	inaccessible Due to cableway	5-18-01-E AMR1						
Bottom Fwd	No	inaccessible Due to cableway	5-18-01-E AMR1						
Top Aft	No	inaccessible Due to cableway	5-26-01-E GTMR						
Bottom Aft	No	inaccessible Due to cableway	5-26-01-E GTMR						

LCS-1 USS FREEDOM
Ultrasonic Inspection of High Stress Frames

Frame	See it?	Notes	Space #	substitute Fr	Chock OK	Chock SM	No Chock	Pen	SW
32 Port top FWD	yes	Deck Plates removed top only	5-26-01-E GTMR		X			SAT	SAT
32 Port top AFT	yes	Deck Plates removed top only	5-26-01-E GTMR		X			SAT	SAT
34 Port (see note 4/)									
Top Fwd	Yes	Deck Plates to be removed	5-26-01-E GTMR	32 Top side				LOP	1/2"
Bottom Fdw	No	inaccessible Due to cableway	5-26-01-E GTMR		N/A				
Top Aft	Yes	behind cables but accessible	5-34-0-E MMR				X	LOP	partial
Bottom Aft	Yes	behind cables but accessible	5-34-0-E MMR		N/A				SAT
34 STBD									
Top Fwd	Yes	Deck Plates to be removed	5-26-01-E GTMR					SAT	SAT
Bottom Fdw	No	inaccessible Due to cableway	5-26-01-E GTMR		N/A				
Top Aft	No	inaccessible Due to cableway	5-34-0-E MMR						
Bottom Aft	No	inaccessible Due to cableway	5-34-0-E MMR		N/A				
45 Port (see note 5/)									
Top Fwd	Yes		5-34-0-E MMR				X	LOP	partial
Bottom Fdw	Yes		5-34-0-E MMR		N/A				SAT
Top Aft	Yes		5-45-01-E AMR 2				X	LOP	partial
Bottom Aft	Yes		5-45-01-E AMR 2		N/A				
45 STBD									
Top Fwd	Yes		5-34-0-E MMR				X	SAT	SAT
Bottom Fdw	Yes		5-34-0-E MMR		N/A				SAT
Top Aft	Yes		5-45-01-E AMR 2				X	SAT	SAT
Bottom Aft	Yes		5-45-01-E AMR 2		N/A				SAT
46 Port (see note 6/)									
Top Fwd	Yes		5-45-01-E AMR 2			X		SAT	SAT
Bottom Fdw	Yes		5-45-01-E AMR 2		N/A				3/8" toe
Top Aft	Yes		5-45-01-E AMR 2			X		SAT	SAT
Bottom Aft	Yes		5-45-01-E AMR 2		N/A				3/8" toe
46 STBD (see note 7/)									
Top Fwd	Yes		5-45-01-E AMR 2			X		LOP	3/4"
Bottom Fdw	Yes		5-45-01-E AMR 2		N/A				SAT
Top Aft	Yes		5-45-01-E AMR 2			X undercut		SAT	SAT
Bottom Aft	Yes		5-45-01-E AMR 2		N/A				SAT

LCS-1 USS FREEDOM
Ultrasonic Inspection of High Stress Frames

Frame	See it?	Notes	Space #	substitute Fr	Chock OK	Chock Sm	No Chock	Pen	SW
53 Port									
Top Fwd	Yes		5-45-01-E AMR 2			X		SAT	SAT
Bottom Fwd	Yes		5-45-01-E AMR 2		N/A				SAT
Top Aft	Yes		5-45-01-E AMR 2			X		SAT	SAT
Bottom Aft	Yes		5-45-01-E AMR 2		N/A				SAT
53 STBD (See note 8/)									
Top Fwd	Yes		5-45-01-E AMR 2			X		SAT	3/8"
Bottom Fwd	Yes		5-45-01-E AMR 2		N/A				SAT
Top Aft	Yes		5-45-01-E AMR 2			X		SAT	SAT
Bottom Aft	Yes		5-45-01-E AMR 2		N/A				SAT
54 Port									
Top Fwd	Yes		5-45-01-E AMR 2		X			SAT	SAT
Bottom Fwd	Yes		5-45-01-E AMR 2		N/A				SAT
Top Aft	NO	tank or void							
Bottom Aft	No	tank or void							
54 STBD									
Top Fwd	Yes		5-45-01-E AMR 2		X			SAT	SAT
Bottom Fwd	Yes		5-45-01-E AMR 2		N/A				SAT
Top Aft	No	tank or void							
Bottom Aft	NO	tank or void							
<p>1/ Aft of Port Frame 21, a 1/2" indication was in the weld 6 3/4" from the bulkhead at a depth of .248"</p> <p>2/ Fwd of STBD Frame 22, a collection of LOP was found from the frame to a distance of approx 7"</p> <p>3/ Aft of STBD Frame 21, a 1/4" indication was found in the weld 10 3/8" from the bulkhead at a depth of .480"</p> <p>4/ Aft of Port Frame 34 a 1 1/2" indication of LOP was found from the bulkhead aft & a second 1" LOP was found 1" forward of Frame 34 and a third 4 1/2" inche LOP was found 8 1/2" forward of the bulkhead. 1/2" SW indication.</p> <p>5/ Fwd of Port BHD Frame 45 a single 1/8" LOP Indication was found 9 5/8" from the bulkhead and aft of the bulkhead 1 1/2" lop</p> <p>6/ Fwd and Aft of Fr 46 Port there were indications on the toes of the fillet weld.</p> <p>7/ FR 46 STD approx 6 1/2" FWD of Frame had LOP at 1/2".. Detectable by SW as well.. Aft of the Frame the plate has undercut 3/32" DEEP</p> <p>8/ Fr 53 STBD 3/8" indication starting 9 7/8" forward of the Fr 53</p>									

Enclosure (2)
Chock Inspection Results

Strake Frame	Port Accessible	Port Chock Size	Port Align	Port Photo	Port Comments	Stbd Accessible	Stbd Chock Size	Stbd Align	Stbd Photo	Stbd Comments
11F	No	-	-			No	-	-		
11A	Yes	?	-		Didn't feel a chock	Yes	?	-	Yes	Didn't feel a chock
12F	Yes	?	-		Could feel a chock	Yes	?	-	Yes	Could feel a chock
12A	Yes	?	-		Could feel a chock	Yes	?	-		Could feel a chock
13F	Yes	?	-		Could feel a chock	Yes	?	-	Yes	Could feel a chock
13A	Yes	?	-		Could feel a chock	Yes	?	-		Could feel a chock
14F	Yes	?	-		Could feel a chock	Yes	?	-		Could feel a chock
14A	Yes	?	-		Didn't feel a chock	Yes	?	-		Could feel a chock
15F	Yes	?	-		Could feel a chock	Yes	?	-		Didn't feel a chock
15A	Yes	?	-		Didn't feel a chock	Yes	?	-		Could feel a chock
16F	Yes	?	-		Could feel a chock	Yes	?	-		Didn't feel a chock
16A	Yes	?	-		Didn't feel a chock	Yes	?	-		Could feel a chock
17F	Yes	?	-		Could feel a chock	Yes	?	-		Didn't feel a chock
17A	Yes	-	-		Didn't feel a chock	Yes	?	-		Could feel a chock
18F	Yes	-	-			Yes	-	-		
18A	No	N/A	-			No	N/A	-		
19F	No	N/A	-			No	N/A	-		
19A	No	N/A	-			No	N/A	-		
20F	No	N/A	-			No	N/A	-		
20A	No	N/A	-			No	N/A	-		
21F	No	N/A	-			No	N/A	-		
21A	No	N/A	-			No	N/A	-		
22F	No	N/A	-			No	N/A	-		
22A	No	N/A	-			No	N/A	-		
23F	No	N/A	-			No	N/A	-		
23A	No	N/A	-			No	N/A	-		
24F	No	N/A	-			No	N/A	-		
24A	No	N/A	-	Yes		No	N/A	-		
25F	No	N/A	-			No	N/A	-		
25A	No	N/A	-			No	N/A	-		
26F	No	N/A	-			No	N/A	-		
26A	Yes	missing			No Dents	Yes	missing			No Dents
27F	Yes	missing			No Dents	Yes	missing			No Dents
27A	Yes	missing			No Dents	Yes	missing			No Dents
28F	Yes	missing			No Dents	Yes	missing			No Dents
28A	Yes	missing			No Dents	Yes	missing			No Dents
29F	Yes	missing			No Dents	Yes	missing			No Dents
29A	Yes	missing			No Dents	Yes	missing			No Dents
30F	Yes	missing			No Dents	Yes	missing			No Dents
30A	Yes	missing			No Dents	Yes	missing			No Dents
31F	Yes	missing			No Dents	Yes	missing			No Dents
31A	Yes	missing			No Dents	Yes	missing			No Dents
32F	Yes	missing			No Dents	Yes	missing			No Dents
32A	Yes	missing			No Dents	Yes	missing			No Dents
33F	Yes	missing			No Dents	Yes	missing			No Dents
33A	Yes	missing			No Dents	Yes	missing		Yes	No Dents
34F	Yes	missing		Yes	No Dents	Yes	missing		Yes	No Dents
34A	Lagging	missing	N/A	Yes	No Dents	Yes	75mm			
35F	No	75X200mm	Good		No Dents	Yes	75mm			
35A	No	75X200mm	Good		No Dents	Yes	75mm			
36F	Yes	75X200mm	Good		No Dents	Yes	75X200mm	Good		No Dents
36A	Yes	75X200mm	Good		No Dents	Yes	75X200mm			
37F	No	75X200mm	Good		No Dents	Yes	75X200mm			
37A	No	N/A				Yes	75X200mm	Good		No Dents
38F	No	N/A				No	N/A			
38A	No	N/A				No	N/A			
39F	No	N/A				No	N/A			
39A	No	75X200mm	Good		No Dents	No	N/A			
40F	Yes	75X200mm	Good		No Dents	No	N/A			
40A	Yes	75X200mm	Good		No Dents	No	N/A			
41F	Yes	75X200mm	Good		No Dents	No	N/A			

Chock Inspection Results

Strake	Port	Port	Port	Port	Port	Stbd	Stbd	Stbd	Stbd	Stbd
Frame	Accessible	Chock Size	Align	Photo	Comments	Accessible	Chock Size	Align	Photo	Comments
41A	Yes	75X200mm	Good		No Dents	Yes	75X200mm	Good		No Dents
42F	Yes	75X200mm	Good		No Dents	Yes	75X200mm	Good		No Dents
42A	Yes	75X200mm	Good		No Dents	Yes	75X200mm	Good		No Dents
43F	Yes	75X200mm	Good		No Dents	Yes	75X200mm	Good		No Dents
43A	Yes	75X200mm	Good		No Dents	Yes	75X200mm	Good		No Dents
44F	Yes	75X200mm	Good		No Dents	Yes	75X200mm	Good		No Dents
44A	Yes	75X200mm	Good		No Dents	Yes	75X200mm	Good		No Dents
45F	Yes	Missing	Good		No Dents	Yes	75x200mm	Good		No Dents
45A	Lagging	Missing	N/A	Yes	No Dents	Lagging	bad feel			
46F	Yes	45mm	Good		No Dents	Yes	45mm			
46A	Yes	45mm	Good		No Dents	Yes	45mm			
47F	Yes	45mm	Good		No Dents	Yes	45mm	Good		No Dent
47A	Yes	45mm	Good		No Dents	Yes	45mm	Good		No Dent
48F	No	45mm	Good		No Dents	Yes	45mm	Good		Dent
48A	No	N/A				Yes	45mm	Good		Dent
49F	No	N/A				Yes	45mm	If by 1/4"		No Dent
49A	No	N/A				Yes	45mm	If by 1/4"	Yes	No Dent
50F	No	N/A				Yes	45mm	Good	Yes	No Dent
50A	No	N/A				Yes	45mm	Good		No Dent
51F	Yes	45mm	Good		No Dents	Yes	45mm	Good		No Dent
51A	Yes	45mm	Good		No Dents	Yes	45mm	Good		No Dent
52F	Yes	45mm	Good		No Dents	Yes	45mm			
52A	Yes	45mm				Yes	45mm			
53F	Yes	45mm				Yes	45mm			
53A	Yes	45mm				Yes	45mm			
54F	Yes	45mm				Yes	45mm			
54A	No	N/A				No	N/A			
55	No	N/A				No	N/A			
55	No	N/A				No	N/A			
56	No	N/A				No	N/A			
56	No	N/A				No	N/A			
57	No	N/A				No	N/A			
57	No	N/A				No	N/A			
58	No	N/A				No	N/A			
58	No	N/A				No	N/A			
59	No	N/A				No	N/A			
59	No	N/A				No	N/A			
60	No	N/A				No	N/A			
60	No	N/A				No	N/A			
61	No	N/A				No	N/A			
61	No	N/A				No	N/A			
62	No	N/A				No	N/A			
62	No	N/A				No	N/A			
63	No	N/A				No	N/A			
63	No	N/A				No	N/A			
64	No	N/A				No	N/A			
64	No	N/A				No	N/A			
65F	No	N/A				No	N/A			
65A	Yes	75X200mm	Good	Yes		Yes	75X200mm	Good	Yes	
66F	Yes	75X200mm	Good	Yes		Yes	75X200mm	Good	Yes	
66A	Yes	75X200mm	Good	Yes		Yes	75X200mm	Good	Yes	
67F	Yes	75X200mm	Good	Yes		Yes	75X200mm	Good	Yes	
67A	Yes	75X200mm	Good	Yes		Yes	75X200mm	Good	Yes	
68F	Yes	75X200mm	Good	Yes		Yes	75X200mm	Good	Yes	
68A	Yes	75X200mm	Good	Yes		Yes	75X200mm	Good	Yes	
69F	Yes	Missing	N/A	Yes		Yes	Missing	N/A	Yes	
69A	No					No				

Enclosure 3)
Revision 1
Feb. 12, 2010

SAFE OPERATING ENVELOPE (SOE) FOR LCS 1

This document presents the Safe Operating Envelopes for the LCS 1 at 3320 ML. This data includes the effects of primary structure loads, secondary wave impact loads, extreme motions (roll > 45 degrees single amplitude), and broaching.

The five SOEs shown provide the **safe operating speed through the water** (in knots) as a function of **relative wave heading** (in degrees). The speed is the speed averaged over 5 minutes. Speed fluctuation due to individual waves may be ignored. Relative wave heading should also be averaged over 5 minutes. 0 degrees corresponds to head seas and 180 degrees corresponds to following seas. There is one SOE each for Sea State 5, for Sea State 6, for Sea State 7, for low Sea State 8, and for high Sea State 8. The observed or significant wave height associated with each SOE is shown on the SOE in feet and meters.

Exceeding the limiting ship speed in head and bow quartering seas will increase the likelihood of ship damage to either primary structure or secondary structure framing due to wave impacts. Exceeding the limiting ship speed in beam, stern quartering, and following seas may lead to structural damage. Exceeding the limiting ship speed in beam, stern quartering and following seas may also lead to very large roll angles. Exceeding the limiting ship speed in stern quartering and following seas will increase the possibility of broaching. The likelihood of damage occurring when operating outside the SOE increases with increasing wave height and speed. For operations outside the SOE in Sea State 7 and Sea State 8, damage in head and bow seas and large roll angles in beam and stern seas are very likely, even after short periods of exposure.

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Figure 1 – Limiting Speed-Heading Profile for LCS 1 in Sea State 5

Figure 2 – Limiting Speed-Heading Profile for LCS 1 in Sea State 6

Figure 3 – Limiting Speed-Heading Profile for LCS 1 in Sea State 7

Figure 4 – Limiting Speed-Heading Profile for LCS 1 in Low Sea State 8

Figure 5 – Limiting Speed-Heading Profile for LCS 1 in High Sea State 8

Figures repeated in B&W

Enclosure 1

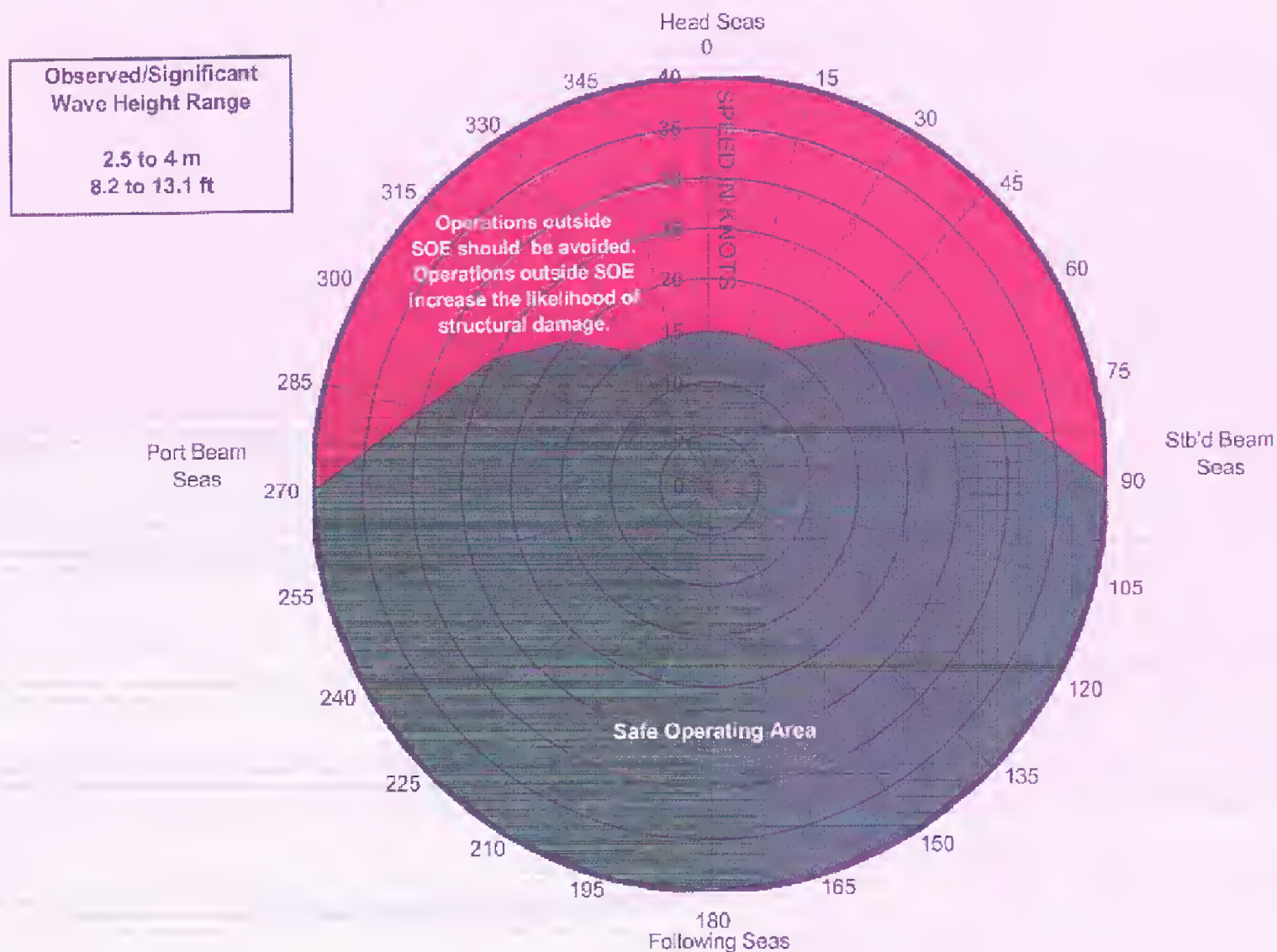
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Figure 1 - Limiting Speed-Heading Profile for LCS 1 in SS 5



Enclosure 1

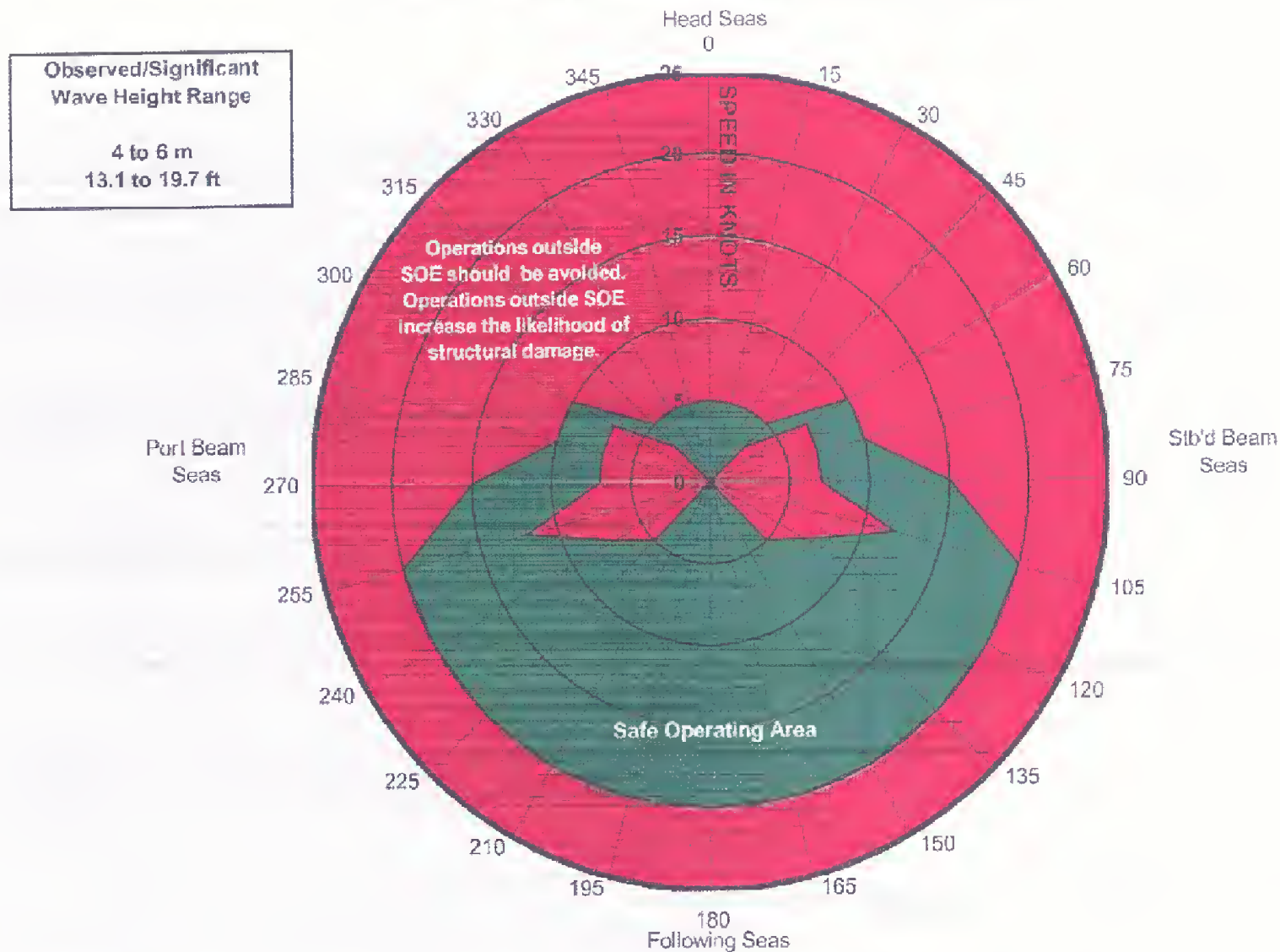
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Figure 2 - Limiting Speed-Heading Profile for LCS 1 in SS 6



Enclosure 1

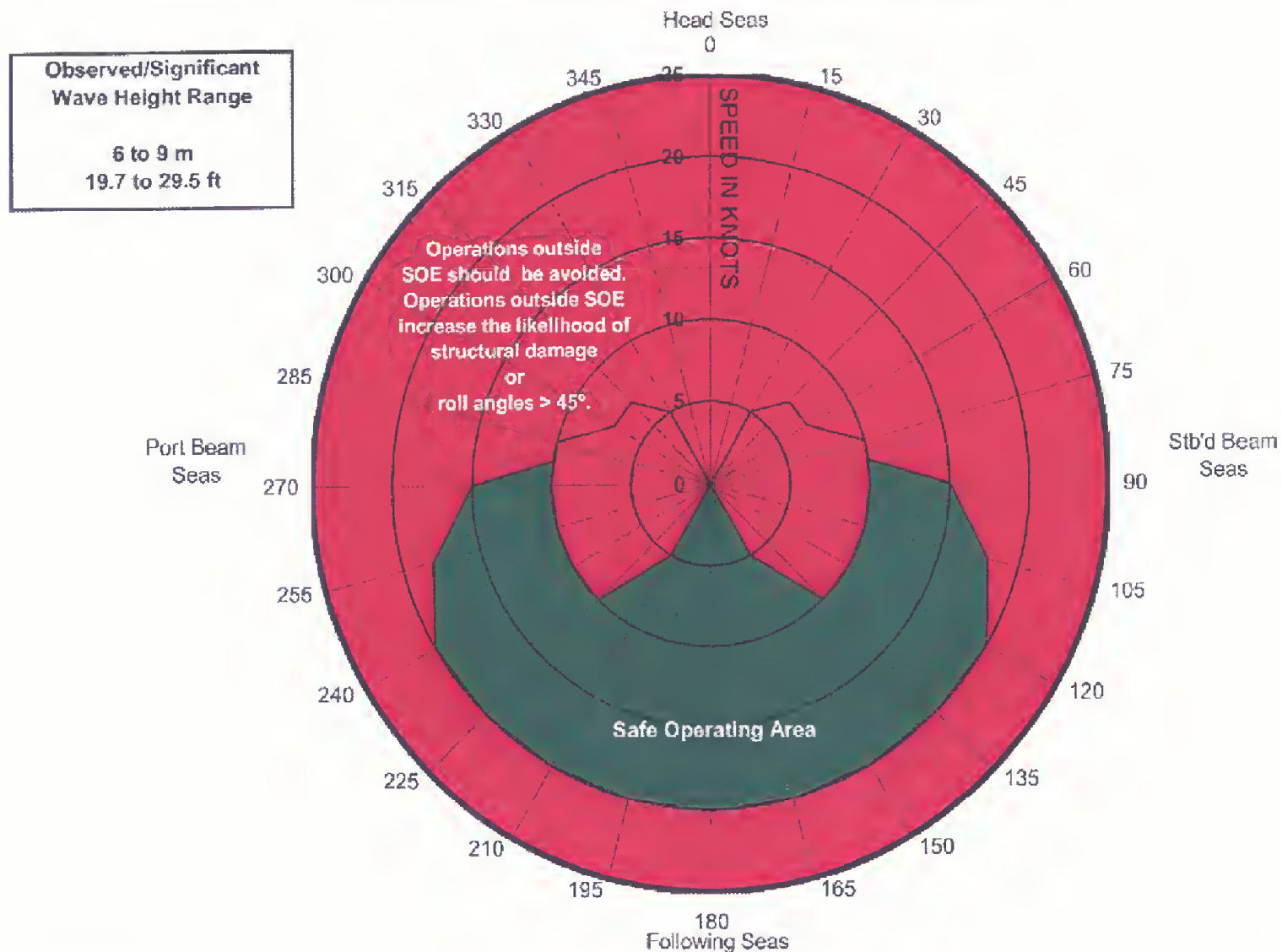
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Figure 3 - Limiting Speed-Heading Profile for LCS 1 in SS 7



Enclosure 1

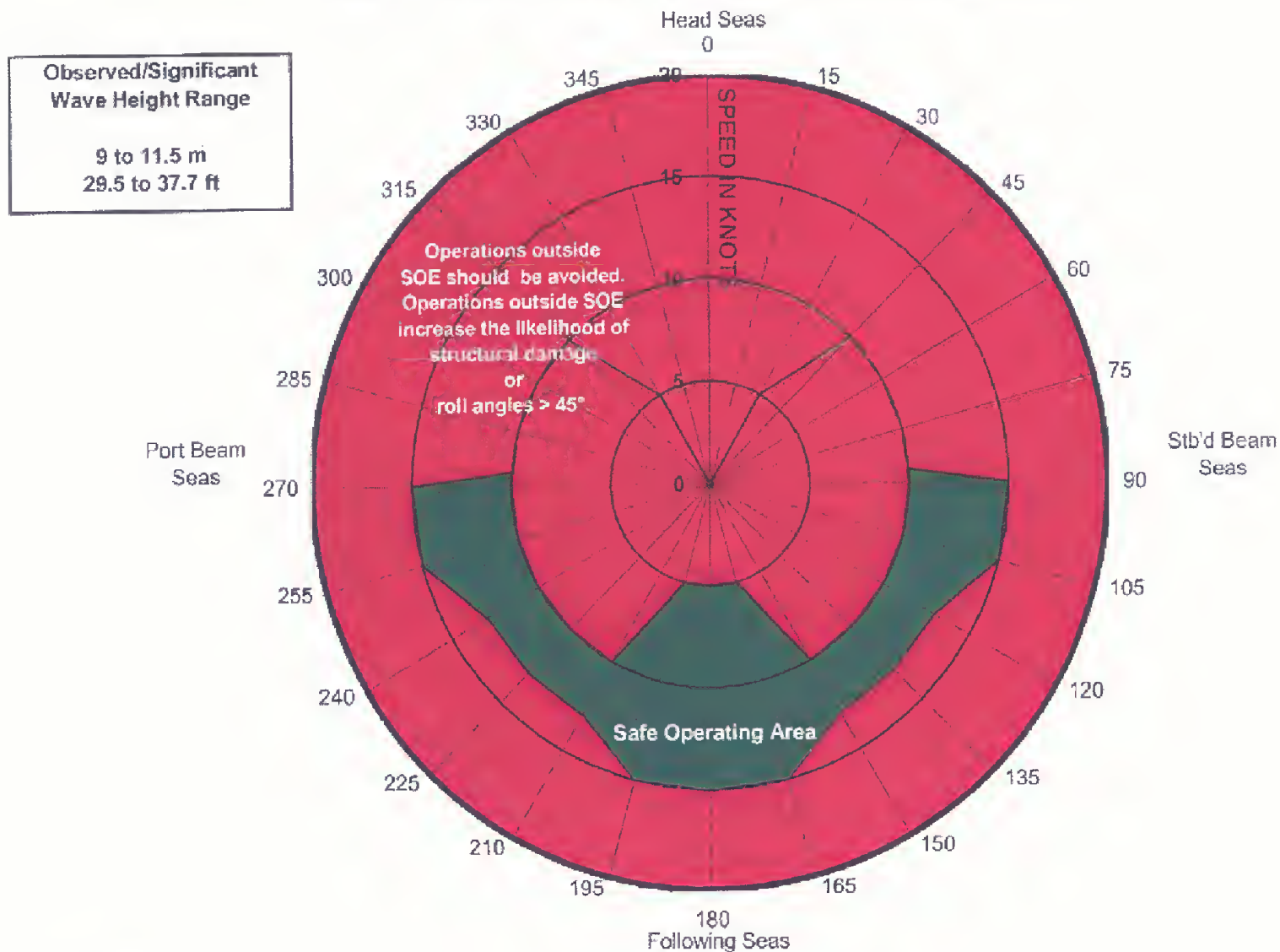
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Figure 4 - Limiting Speed-Heading Profile for LCS 1 in Low SS 8



Enclosure 1

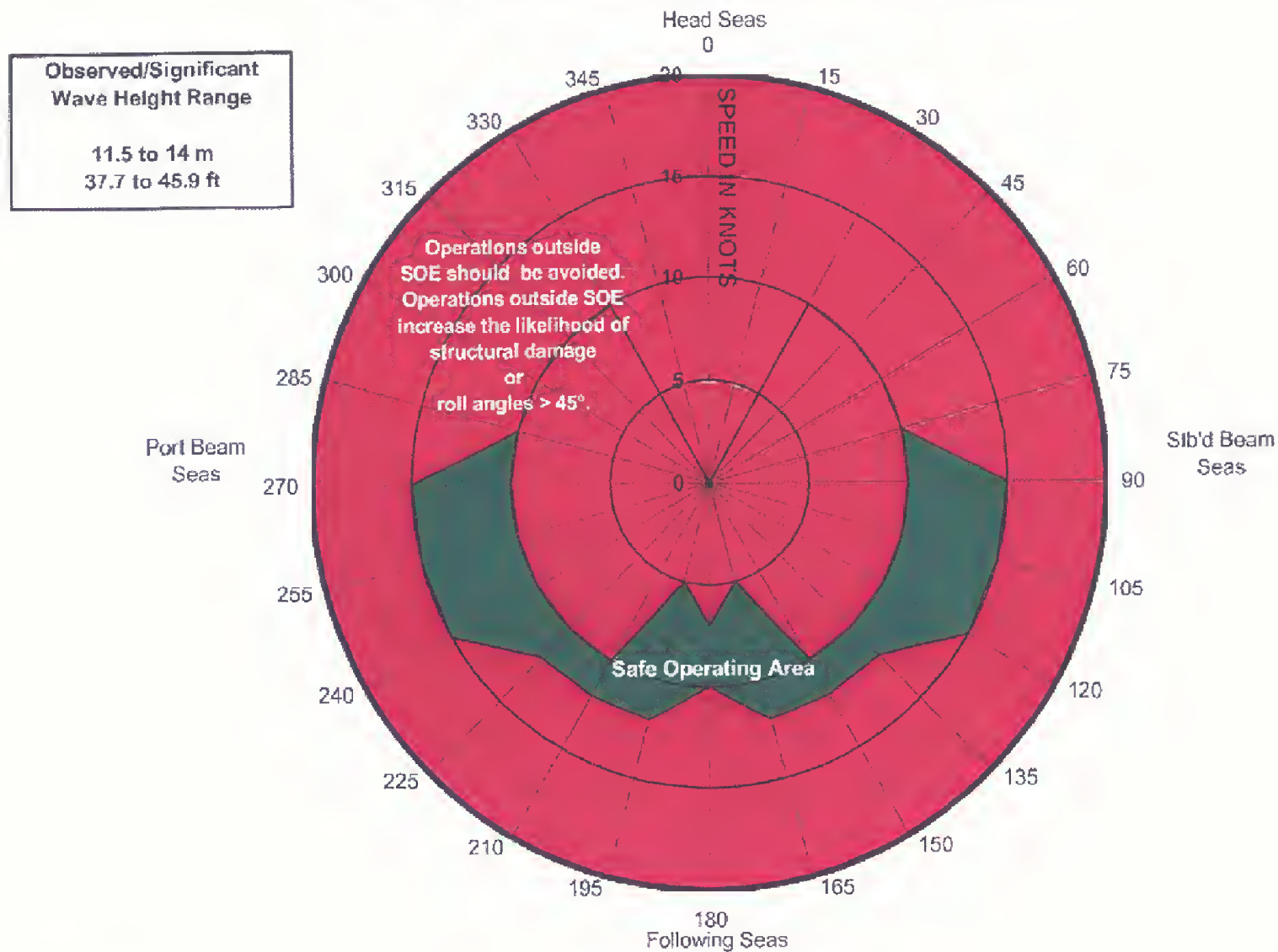
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Figure 5 - Limiting Speed-Heading Profile for LCS 1 in High SS 8



Enclosure 1

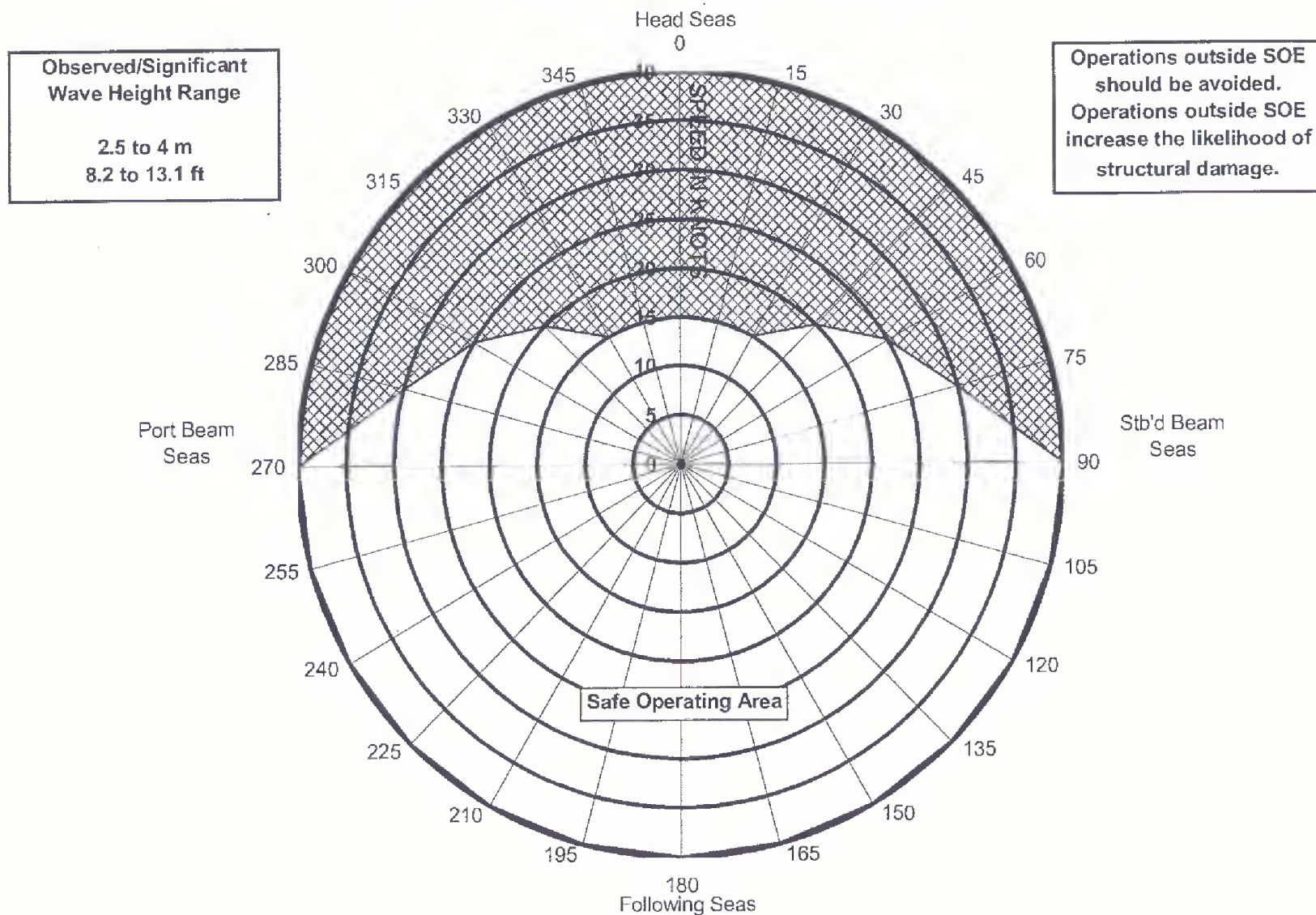
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Figure 1 - Limiting Speed-Heading Profile for LCS 1 in SS 5



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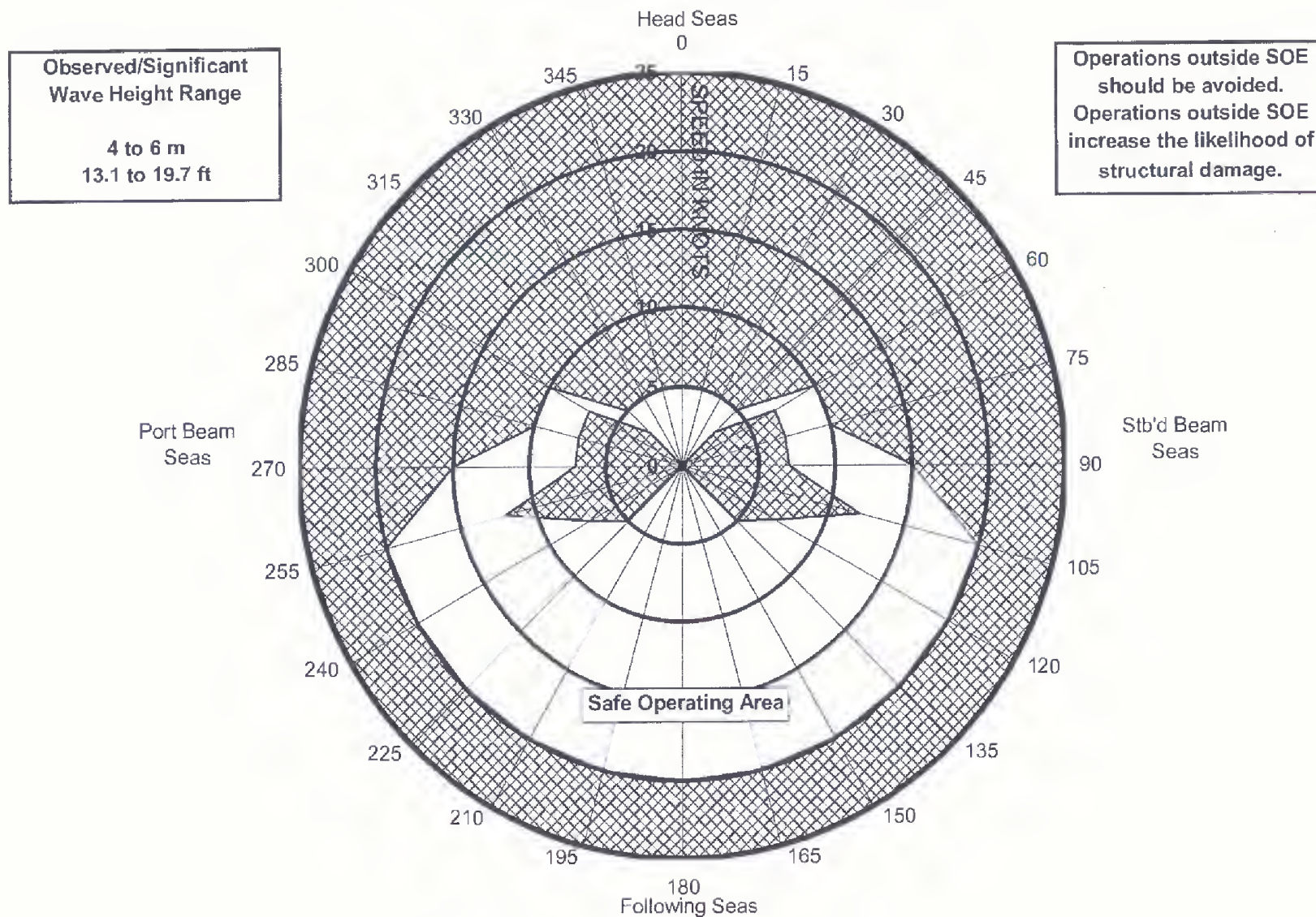
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Figure 2 - Limiting Speed-Heading Profile for LCS 1 in SS 6



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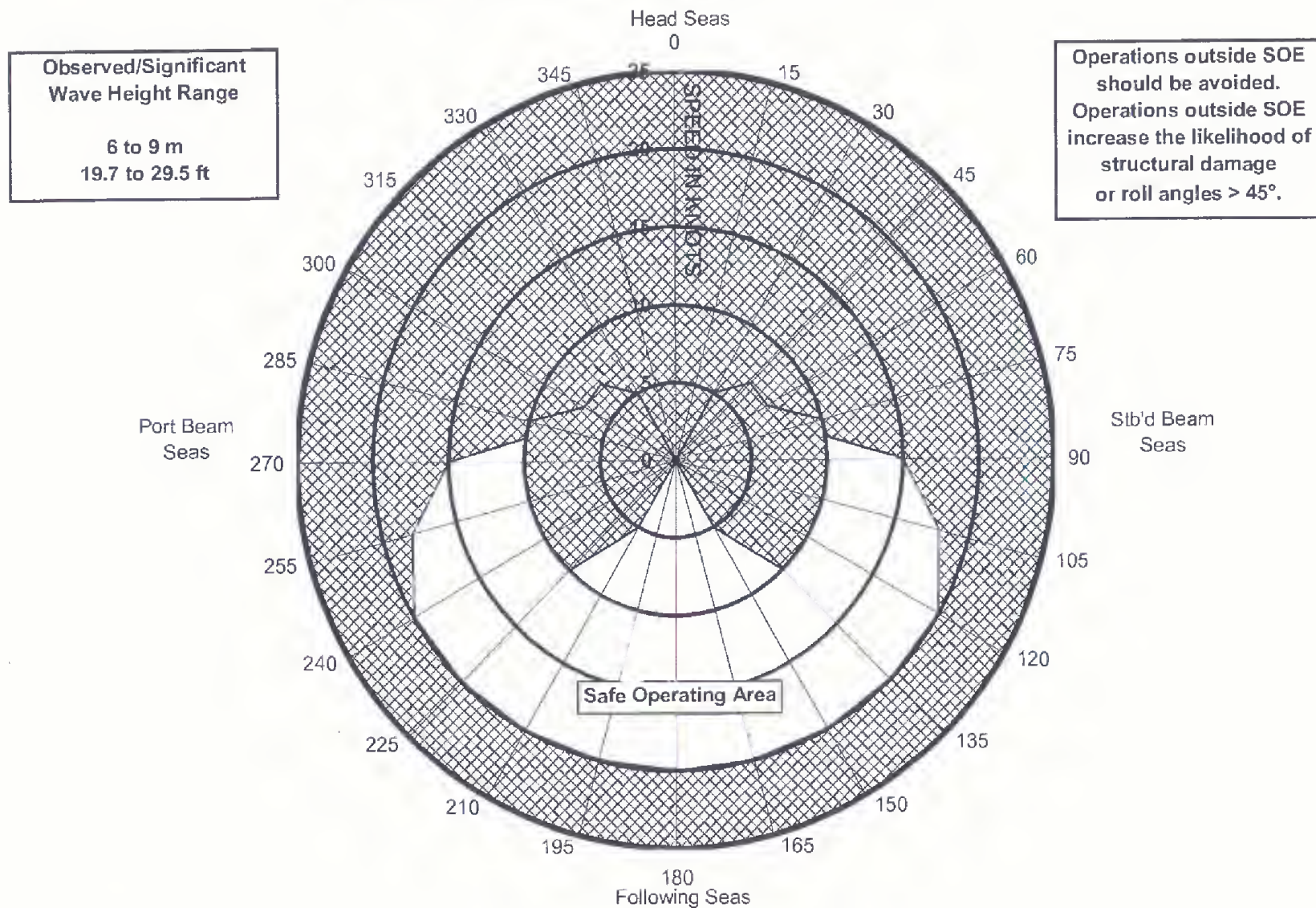
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Figure 3 - Limiting Speed-Heading Profile for LCS 1 in SS 7



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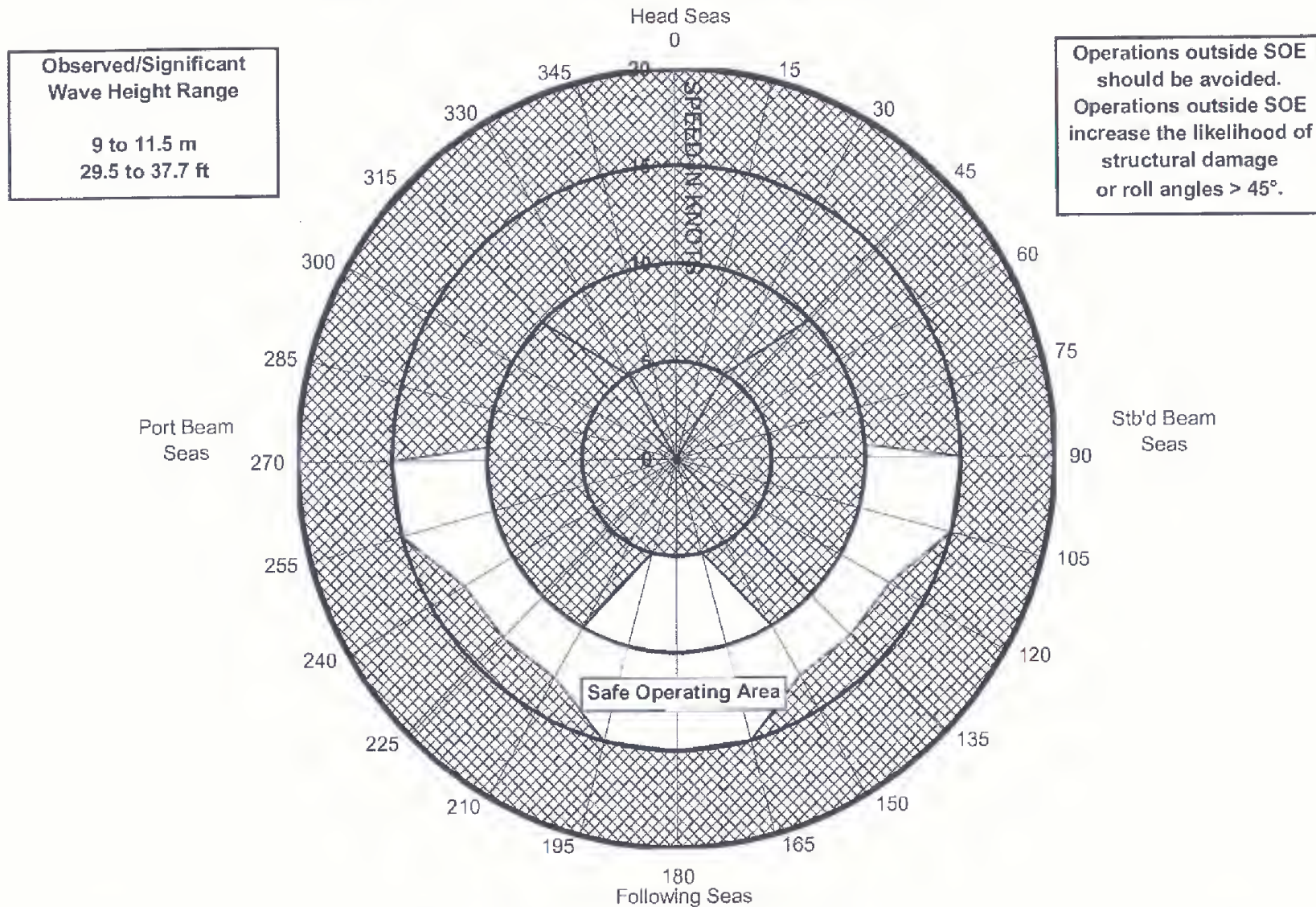
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Figure 4 - Limiting Speed-Heading Profile for LCS 1 in Low SS 8



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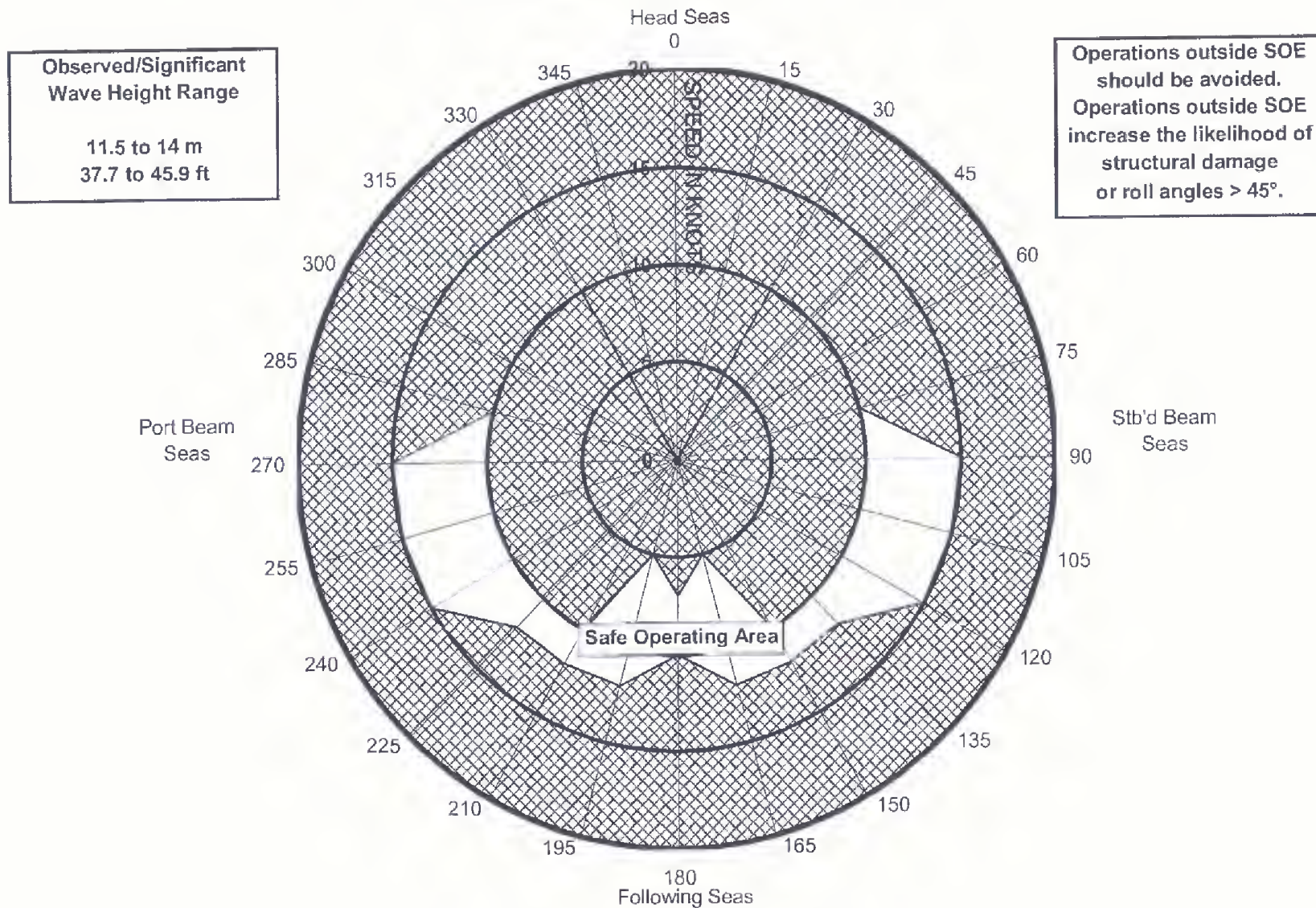
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Figure 5 - Limiting Speed-Heading Profile for LCS 1 in High SS 8



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